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| APPLICATION NO. | FILING DATE | FIRST NAMED INVENTOR | ATTORNEY DOCKET NO. | CONFIRMATION NO. |
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| 10/810,415 | 03/25/2004 | Miika Leinikka | ASMMC.057AUS | 8921 |

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| EXAMINER | |
|---|---|
| CHAMBLISS, ALONZO | |
| **ART UNIT** | **PAPER NUMBER** |
| 2814 | |

DATE MAILED: 11/30/2005

Please find below and/or attached an Office communication concerning this application or proceeding.

| Office Action Summary | Application No. | Applicant(s) | |
|---|---|---|---|
| | 10/810,415 | LEINIKKA ET AL. | |
| | Examiner | Art Unit | |
| | Alonzo Chambliss | 2814 | |

*-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --*

**Period for Reply**

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

**Status**

1)☒ Responsive to communication(s) filed on *09 September 2005*.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

**Disposition of Claims**

4)☒ Claim(s) *1-52* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-52* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

**Application Papers**

9)☒ The specification is objected to by the Examiner.

10)☒ The drawing(s) filed on *25 March 2004* is/are: a)☐ accepted or b)☒ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

**Priority under 35 U.S.C. § 119**

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

**Attachment(s)**

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☒ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date *6/25/04*.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____.
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: _____.

## DETAILED ACTION

### *Election/Restrictions*

1. Applicant's election without traverse of claims 1-52 in the reply filed on 9/9/05 is acknowledged.

2. Claims 53-62 are withdrawn from further consideration pursuant to 37 CFR 1.142(b) as being drawn to a nonelected claims, there being no allowable generic or linking claim.

### *Information Disclosure Statement*

3. The information disclosure statement (IDS) submitted on 6/25/04 was filed after the mailing date of the non-final rejection on 11/28/05. The submission is in compliance with the provisions of 37 CFR 1.97. Accordingly, the information disclosure statement is being considered by the examiner.

### *Drawings*

4. The drawings are objected to as failing to comply with 37 CFR 1.84(p)(5) because they include the following reference character(s) not mentioned in the description: 116, 130, 140, and 326. Corrected drawing sheets in compliance with 37 CFR 1.121(d), or amendment to the specification to add the reference character(s) in the description in compliance with 37 CFR 1.121(b) are required in reply to the Office action to avoid abandonment of the application. Any amended replacement drawing sheet should include all of the figures appearing on the immediate prior version of the

sheet, even if only one figure is being amended. Each drawing sheet submitted after the filing date of an application must be labeled in the top margin as either "Replacement Sheet" or "New Sheet" pursuant to 37 CFR 1.121(d). If the changes are not accepted by the examiner, the applicant will be notified and informed of any required corrective action in the next Office action. The objection to the drawings will not be held in abeyance.

### *Specification*

5. The title of the invention is not descriptive. A new title is required that is clearly indicative of the invention to which the claims are directed. The following title is suggested: " METHOD OF FABRICATING A SEED LAYER ".

### *Claim Objections*

6. Claim 16 IS objected to because of the following informalities: the claim dependency is not correct. Appropriate correction is required.

### *Claim Rejections - 35 USC § 112*

7. The following is a quotation of the second paragraph of 35 U.S.C. 112:

> The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

8. Claims 33-52 are rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention.

9. In claim 33, the phrase "repeating the preparation process on the substrate n times, wherein n = 0, 1, or 2)" since it is not clear from how the repeating process can be preformed when n = 0.

***Claim Rejections - 35 USC § 102***

10. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless –
>
> (b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

11. Claims 1-4, 10-13, 15-19, 21-24,28, 33-37, 48, 49, and 52, insofar as definite are rejected under 35 U.S.C. 102(b) as being clearly anticipated by Soininen et al. (US 6,482,740).

With respect to Claims 1, 19, 33, 48, and 49, Soininen teaches depositing a diffusion barrier 14 on a substrate and oxidizing a top layer of the diffusion barrier 14 to form a metal oxide layer 16 (i.e. nucleation layer). A preparation process on the substrate is done to form a nucleation layer 16. The preparation process is done when n = 1 - 10. Reducing the oxidation state of the metal oxide layer 16 to form a first seed layer 16 and depositing a conductor 18 (i.e. Cu) directly on the first seed layer 16 (see col. 1 lines 25-47, col. 5 lines 45-52, and col. 6 lines 25-50).

With respect to Claim 2, Soininen teaches depositing a diffusion barrier layer comprises an atomic layer deposition process (see col. 6 lines 27-54).

With respect to Claims 3 and 4, Soininen teaches depositing a diffusion barrier comprises a tantalum nitride layer (see col. 5 lines 45-58).

With respect to Claim 10, Soininen teaches wherein oxidizing the top layer of the barrier layer comprises exposing the barrier layer to an oxygen source chemical (see col. 6 lines 35-55).

With respect to Claim 11, Soininen teaches wherein the oxygen source is hydrogen peroxide (see col. 11 lines 26-32).

With respect to Claim 12, Soininen teaches repeating oxidizing and reducing the top of the barrier layer before depositing the conductor directly on the first seed layer (see claims 22 and 24).

With respect to Claim 13, Soininen teaches wherein oxidizing and reducing the top of the barrier layer is repeated between about 10 and 50 times (see claim 24).]\

With respect to Claims 15-18, 34, and 35, Soininen teaches wherein depositing the conductor comprises depositing a second seed layer (i.e. ruthenium) by ALD (see col. 5 lines 1-14). Thus, allowing the copper to be deposited directly over the second seed layer.

With respect to Claims 21, 22, and 52, Soininen teaches wherein depositing copper comprises an electrochemical deposition, electroless, or CVD process (see col. 3 lines 15-17).

With respect to Claim 23, Soininen teaches wherein reducing comprises reducing the metal oxide to an elemental metal form (see col. 5 lines 10-14, col. 6 lines 40-42 and col. 7 lines 35-37).

With respect to Claims 24 and 28, Soininen teaches wherein reducing the oxidation state comprises using hydrogen plasma and exposing the metal oxide to a gaseous compound containing a functional from the group comprising alcohol(-OH), aldehyde (-CHO), and carboxylic acid (-COOH) (see col. 11 lines 58-60 and col. 12 lines 61-65).

With respect to Claim 27, Soininen teaches wherein the reducing the oxidation state comprises an electrochemical process (i.e. current applied to the metal) (see col. 3 lines 15-35).

With respect to Claim 36, Soininen teaches wherein the preparation process comprises exposing the substrate to a pulse of oxygen in a reactor chamber, purging the reactor chamber with an inert gas, exposing the substrate to a pulse of hydrogen, and purging the reactor chamber with an inert gas (see col. 6 lines 55-67 and col. 7 lines 20).

With respect to Claim 37, Soininen teaches exposing the substrate to a pulse for a ruthenium source chemical and purging the reactor chamber before exposing the substrate to the oxygen pulse (see col. 6 lines 25-67, col. 7 lines 20-67, and col. 8 lines 1-67).

### *Claim Rejections - 35 USC § 103*

12. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the

> invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

This application currently names joint inventors. In considering patentability of the claims under 35 U.S.C. 103(a), the examiner presumes that the subject matter of the various claims was commonly owned at the time any inventions covered therein were made absent any evidence to the contrary. Applicant is advised of the obligation under 37 CFR 1.56 to point out the inventor and invention dates of each claim that was not commonly owned at the time a later invention was made in order for the examiner to consider the applicability of 35 U.S.C. 103(c) and potential 35 U.S.C. 102(e), (f) or (g) prior art under 35 U.S.C. 103(a).

13. Claims 5-9, 14, 25, 26, 29-32, 44-47, 50 are rejected under 35 U.S.C. 103(a) as being unpatentable over Soininen et al. (US 6,482,740) as applied to claims 1 and 33 above, and further in view of Elers et al. (WO 01/29893).

With respect to Claims 5-9 and 29, Soininen discloses the claimed invention except for the diffusion barrier comprising tungsten carbide or tungsten nitride carbide layer. However, Elers discloses depositing a diffusion barrier comprising tungsten carbide or tungsten nitride carbide layer by ALD (see pages 5, 9, and 10,claims 1-9). Thus, Soininen and Elers have substantially the same environment of a barrier layer deposited on a substrate by ALD. Therefore, one skilled in the art at the time of the invention would readily recognize substitute the carbide layer for the nitride layer of Soininen, since the carbide layer would facilitate high quality ultra thin layer while providing a corrosion protection for the substrate as taught by Elers.

With respect to Claims 14 and 50, one skilled in the art would readily recognize oxidizing and reducing the top of the barrier layer is repeated between about 20 and 40 times, since repeated steps would define the desired thickness of the barrier layer base the need of the semiconductor device.

With respect to Claims 25, 26, 44, and 45, one skilled in the art at the time of the invention would readily recognize substituting either an in-situ or remote hydrogen plasma for the hydrogen plasma, since both process would provide a stable method of for creating a seed layer on the barrier layer with a controlled rate.

With respect to Claims 30-32, Soininen discloses wherein depositing the conductor comprises depositing a second seed layer (i.e. ruthenium) by ALD over a first seed layer (see col. 5 lines 1-14).

With respect to Claim 46 and 47, Elers discloses the diffusion barrier layer comprising a tungsten nitride carbide or molybdenum nitride carbide (see pages 5, 9, and 10,claims 1-9).

14. Claims 20 and 51 are rejected under 35 U.S.C. 103(a) as being unpatentable over Soininen et al. (US 6,482,740) as applied to claim 1, and further in view of Chen et al. (US 6,753,249).

With respect to Claims 20 and 51, Soininen fails to disclose depositing copper by electrochemical deposition process. However, it is well known in the semiconductor industry that copper can be deposited by electrochemical deposition as evident by Chen (see col. 5 lines 14-17). Therefore, it would have been obvious to one substitute

electrochemical deposition for electroless deposition since the electrochemical deposition would provide a reliable process to fill the trench as taught by Chen.

15. Claim 38-43 are rejected under 35 U.S.C. 103(a) as being unpatentable over Soininen et al. (US 6,482,740) as applied to claims 33 and 36, and further in view of Aaltonen et al. (US 2003/0165615).

With respect to Claims 38-43, Soininen fails to explicitly recite the pulse of hydrogen and oxygen. However, it is well known in the semiconductor industry to have a hydrogen and oxygen pulse of 10 seconds or more as evident by Aaltonen (see paragraphs 53, 55, and 60, claims 1 and 11). Therefore, it would have been obvious to one skilled in the art to incorporate a pulse of 10 seconds or more with the process of Soininen, since the pulse would yield desired thickness of the film layer in an ALD environment as taught by Aaltonen.

The prior art made of record and not relied upon is cited primarily to show the product of the instant invention.

## Conclusion

16. Any inquiry concerning the communication or earlier communications from the examiner should be directed to Alonzo Chambliss whose telephone number is (571) 272-1927.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the Group receptionist whose telephone number is (703) 308-7956

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system Status information for published applications may be obtained from either Private PMR or Public PMR. Status information for unpublished applications is available through Private PMR only. For more information about the PMR system see http://pair-dkect.uspto.gov. Should you have questions on access to the Private PMR system contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free) or EBC_Support@uspto.gov.

Alonzo Chambliss
Primary Patent Examiner
Art Unit 2814

**AC**/November 28, 2005